RFDESIGN

RFD900x-US Radio Modem User Manual

902-928MHz frequency band

General Cautions

During operation there must be a separation distance of 20cm between all persons and the antenna.
Ensure that all used RF connectors are secure and properly terminated.

When used in the US - FCC Caution

Caution: The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

 If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
—Reorient or relocate the receiving antenna.
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC's RF radiation exposure limits set forth for an uncontrolled environment. The antenna(s) used for this transmitter must be installed and operated to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter. Installers must ensure that 20cm separation distance will be maintained between the device (excluding its handset) and users.

When used in Canada - ISED Caution

This device complies with RSS 210 of the Industry Canada Rules. Operation is subject to the following two conditions:
(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
(1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with Canada radiation exposure limits set forth for uncontrolled environments. This equipment should be installed and operated with a minimum distance of 20cm （may be adjusted according to actual calculation result） between the radiator and your body.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
Déclaration d'IC sur l'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux radiations définies par le Canada pour des environnements non contrôlés. Cet équipement doit être installé et utilisé à une distance minimum de 20 cm entre l'antenne et votre corps.

Cet émetteur ne doit pas être installé au même endroit ni utilisé avec une autre antenne ou un autre émetteur

Acceptable Antennas - US

This device has been designed to operate with the antenna(s) listed below and having a maximum gain of 3 dBi. Antennas not included in this list or having a gain greater than 3 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Acceptable antenna – 3dBi RFD whip.

Acceptable Antennas - Canada

This radio transmitter 24610-900X2 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Acceptable antenna – 3dBi RFD whip.

Table of contents

1 Key Features

Features

- Out of the box RF communications.
- Air data rate speeds of up to 224kbps
- Diversity antenna support
- Weight of 14g
- Outdoor RF line-of-site range of 40km or more depending on antenna configuration

Operational

- Operating voltage: 5V, I/O Voltage (3.3V)
- Temperature range: -40°C to +85°C
- Dimensions of 30mm x 57.7mm x 12.8mm
- Current consumption:
    TX mode: ~1A peak at +30dBm,
    RX mode: 60mA (typical)

Applications

- Telemetry data
- UAV control
- Remote weather station
- House automation
- Long range RC

2 Specifications

Performance	
Supported RF Data Rates	12 to 224 kbps dependent on type and version of firmware
Indoor Range	500m – 1km
Line-Of-Sight Range	40km or more depending on antennas and settings
Transmit Power	0 to 30dBm in 1dBm steps
Receiver Sensitivity	>121dBm at low data rates
Low Noise Amplifier	>20dB gain

Features	
Serial Data Interface	+3.3V nominal, 3.3V tolerant
Configuration Method	AT Commands, APM Planner, RF Design Modem Tools
Frequency Band	902MHz - 928MHz
Interference Immunity	FHSS (Frequency Hopping Spread Spectrum)
Serial Interface Data Rate	2400 to 1000000 bps dependent on type and version of firmware
Antenna Connection	2 x RPSMA diversity switched ports
GPIO	6 pins (Digital, PPM capable)
Compliance Standards	FCC Part 15.247, AS/NZS 4268:2012

Networking and Security	
Addressing Options	Network ID: 0 –255
Channels	Up to 51 Frequency Hopping Channels
Supported Network Topologies	Point-to-point and asynchronous mesh[1] and multipoint synchronous mesh[1]

[1] Only available in separate firmware versions available on the RFD website

Power Requirements	
Supply Voltage	+5V nominal (+5V min, +5.5V Max, +6V ABS Max),
Transmit Current	~1A peak at max power
Receive Current	~60mA

3 OEM Labelling

For equipment containing the RFD-900x-US where the RFD-900x-US label is not visible the following applies.

Equipment using the RFD 900x-US in the USA must display a label referring to the enclosed module. This label must contain the words "Contains FCC ID: 2ADLE-900X2".

Equipment using the RFD 900x-US in Canada must display a label referring to the enclosed module. This label must contain the words "Contains IC ID: 24610-900X2".

4   Pin signals and layout

| Pin #	Name	Direction	Description	Max Voltage
1	GND	-	Ground	0V
2	GND	-	Ground	0V
3	CTS	Either	Clear to send	3.3V
4	Vcc	-	Power supply	5V
5	Vusb	-	Power supply from USB	5V
6	Vusb	-	Power supply from USB	5V
7	RX	Input	UART Data In	3.3V
8	GPIO5/P3.4	Either	Digital I/O	3.3V
9	TX	Output	UART Data Out	3.3V
10	GPIO4/P3.3	Either	Digital I/O	3.3V
11	RTS	Either	Request to send	3.3V
12	GPIO3/P1.3	Either	Digital I/O	3.3V
13	GPIO0/P1.0	Either	Digital I/O	3.3V
14	GPIO2/P1.2	Either	Digital I/O	3.3V
15	GPIO1/P1.1	Either	Digital I/O, PPM I/O	3.3V
16	GND	-	Ground	0V
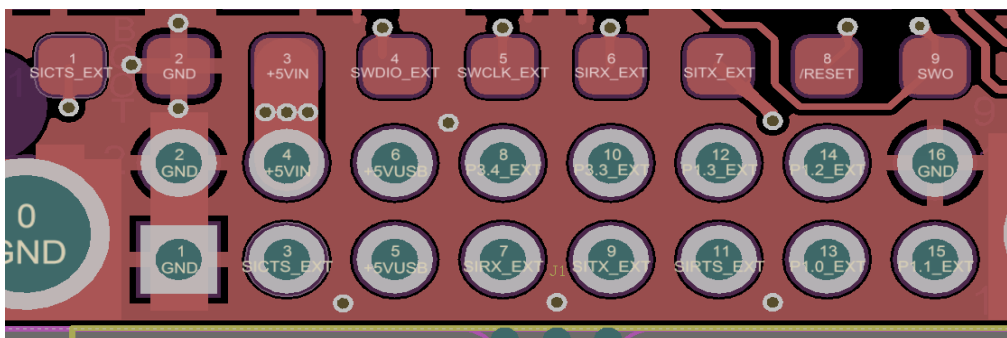
Figure 5-1: Physical pin layout of the RFD900x Radio Modem

GPIO pins will configure for 40kOhm pull down or pull up based on setting as input or output. They can sink or source approximately 5 mA each.

5   Physical dimensions
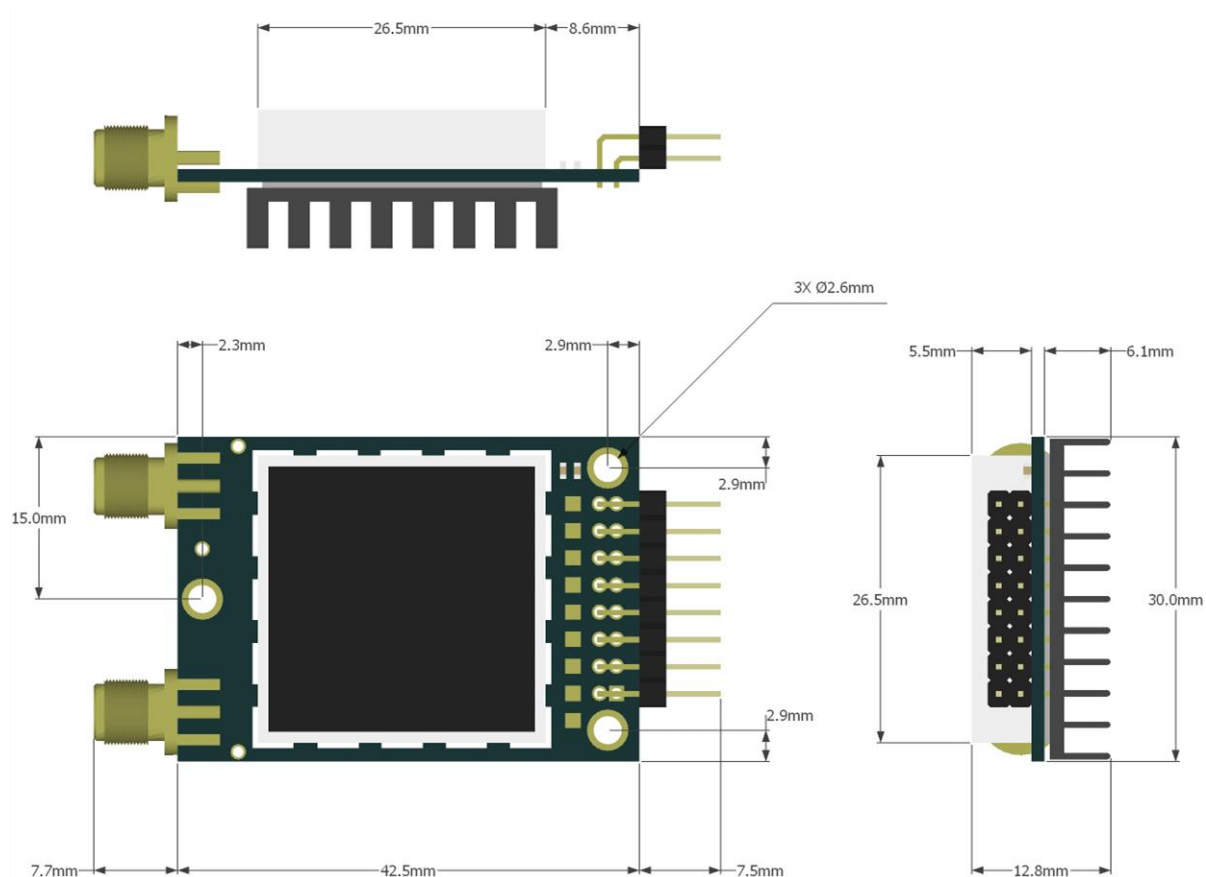
6   Software/GCS Support

The default firmware (see "Useful Links") is a development of the open source project called "SiK" and was created by Mike Smith. It has been further developed and modified by Andrew Tridgell and RFDesign.

The modems feature a boot loader to facilitate field upgrade of the modem firmware via the serial port. This is most easily performed by using the latest version RFD Modem tools (see "Useful links")

Parameters such as power levels, air data rates, serial speeds, GPIO pins etc can all be custom set by the user using the AT Command set, the RFD Modem Tools V2 or later and APM Planner.

Default serial port settings are as follows:

- 57600 baud

- No parity

- 8 data bits

- 1 stop bit

The RFD900x Radio Modem has many software features including:

- Frequency Hopping Spread Spectrum

- Transparent Serial Link

- Configuration by AT commands for local radio, RT Commands for remote radio

- User configurable serial data rates and air data rates

- Error correction routines

- 128-bit AES hardware encryption with user settable key

- MAVLink protocol framing (user selectable)

- MAVLink radio status reporting (Local RSSI, Remote RSSI, Local Noise, Remote Noise)

- Automatic antenna diversity switching on a packet basis in real-time

- Automatic duty cycle throttling based on radio temperature to avoid overheating

- PPM (R/C signal) pass through (Control vehicle across radio).

- GIPO pin mirroring

7   Diversity

The RFD900x has two antenna ports and firmware which supports diversity operation of antennas. During the receive sequence the modem will check both antennas and select the antenna with the best receive signal. The antenna selected during receive is then also used for subsequent transmission. In the case of only one antenna connected, it will automatically select the port with the antenna connected. Testing by Silicon Labs has shown that link budgets can be improved up to the order of 8dB by employing a diversity scheme.

7.1   Spatial diversity

Spatial diversity is the case where the antennas are separated by some distance from one another. It is recommended that two antennas connected to the RDF900 modem be separated by at least 25cm, more if possible.

7.2   Polarisation diversity

Polarisation diversity is the case where the antennas are perpendicular to each other. i.e. one vertical, and one horizontal. This is effective in reducing multipath effects which affect one or the other polarisation. This scheme also helps to maintain the link between non-static objects such as aircraft performing acrobatics by increasing the likelihood that one antenna will maintain the same polarisation as an antenna on the other side of the link. Figure 8-1 depicts how two right-angle monopole antennas can be positioned to achieve polarisation diversity.

Figure 8-1: Antenna configuration to achieve polarisation diversity

8 Network options

RFD900x support firmware for simple pair (peer to peer), asynchronous mesh network and multipoint network. Available for download from the website (see "Useful Links").

8.1 Simple pair (P2P)

The out-of-the-box firmware of the RFD900x radio modem is set to work in simple pair mode. If you purchased a bundle, you are only required to connect the antennas and supply to initiate the link. As soon as the pair synchronises, the on-board LED will become solid green.
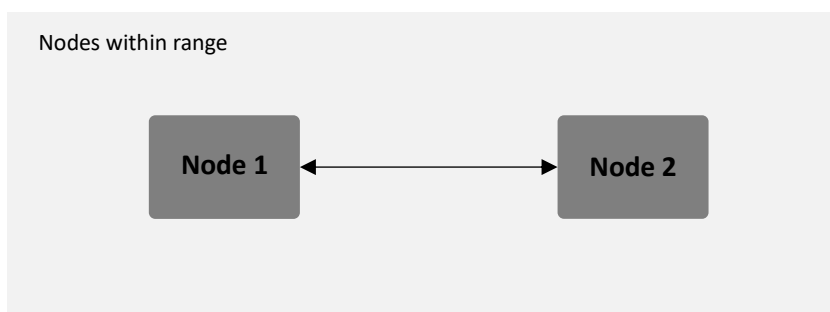

Nodes within range

Node 1 ⟷ Node 2

Figure 8-1 Peer to peer modem pair network

8.2 Asynchronous non-hopping mesh

The asynchronous non-forwarding mesh firmware offers a straight forward communication option that allows the user to quickly transmit and receive data across a great distance between two or more nodes. Figure 9-2 depicts this communication topology. If all the nodes are within range and have compatible parameters, communication between them will succeed.
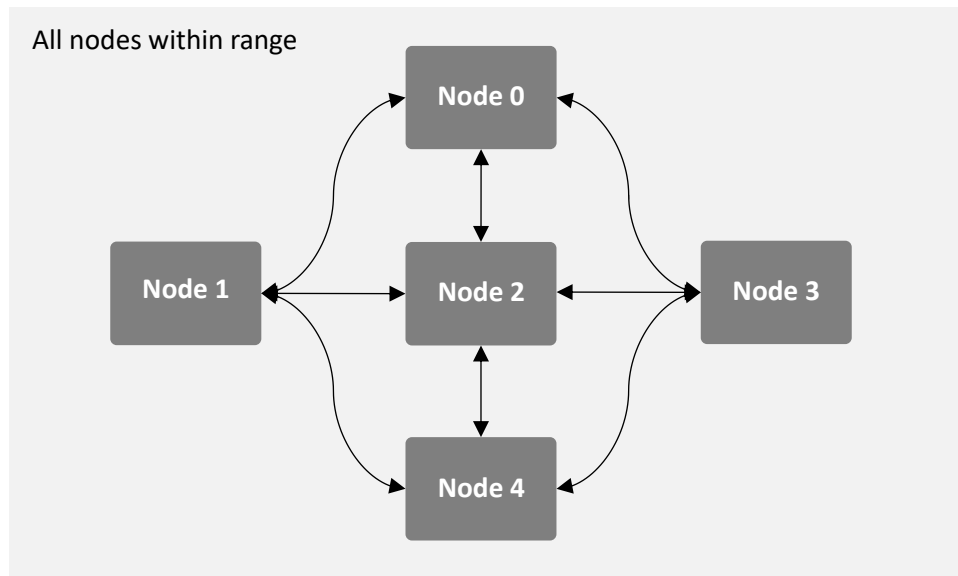
All nodes within range

Figure 8-2 Asynchronous mesh topology

It is also possible to establish forwarding between nodes in the network. (See the asynchronous firmware datasheet for details)

8.3   Multipoint synchronised mesh

The network requires that one of the devices assumes a *base* role to control the timeslot distribution of the surrounding radios. If one the nodes is out of the base's range, communication is still possible if the parameter *SyncAny* is properly set.
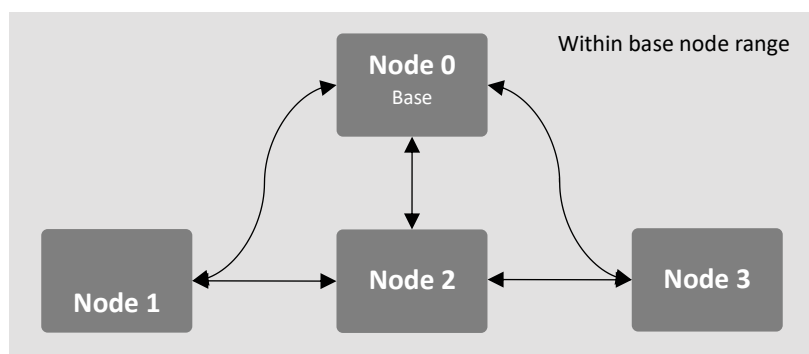

Figure 8-3 Multipoint mesh topology

9 Frequently asked questions (FAQ)

9.1 How many antennas do I need to use?

One is the minimum. Two is recommended.

9.2 How do I connect the FTDI cable to the modem?

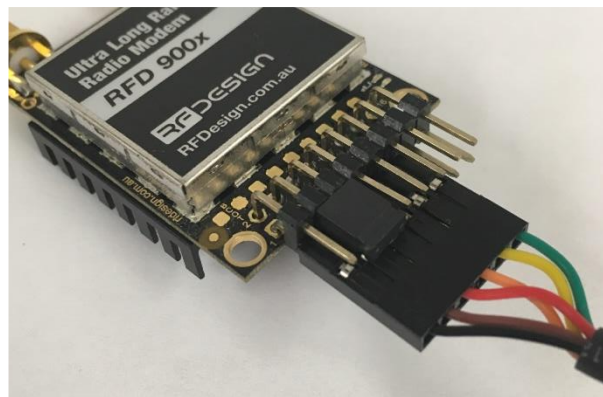The black cable of the FTDI (pin 1) should connect to pin 1 on the modem as shown in Figure 10-1.

Figure 10-1: An FTDI cable connected to the RFD900x modem

9.3 What do I need to upload the firmware or to change the modem configuration?

Download the latest firmware (see "Useful Links"). Download the RFD900x Modem Tools (see "Useful Links"). Connect the FTDI cable to the modem and to a computer. Use the RFD900x Modem Tools to upload the latest firmware or to change the modem configuration (see "RFD900x Modem Tools User Manual").

9.4 I upgraded to asynchronous firmware and the modems don't connect anymore?

The default setting for a modem is to have a NODEID set to 1 and DESTID set to 2. As communication is addressed NODEID must be different for all units and DESTID will set the modems to connect to.

9.5 How do I configure 2 base stations and one Airborne platform with 3 modems? (Asynchronous)

Set the Airborne platform as follows:

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```
NODEID = 1

DESTID = 65535, (32768 from version 2.45F)

MAVLINK = 1
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Set the ground station as follows:

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NODEID = 2 or 3

DESTID = 1

MAVLINK = 1
```

This will allow the airborne modem to handover to multiple ground stations as it flies from the coverage area of one ground station, to another. Both ground stations can be connected and can control the Airborne platform simultaneously. (APM Planner using MAVLink)

10 Useful links

RFD900x-US Firmware
http://rfdesign.com.au/firmware/
> RFD SiK firmware is default
> RFD Asynchronous firmware
> RFD Multipoint firmware

RFD900x-US Flash Programmer
http://rfdesign.com.au/downloads/

FTDI Cable documentation
http://www.ftdichip.com/Support/Documents/DataSheets/Cables/DS_TTL-232R_CABLES.pdf

11 Revision History

Version	Date	Changes
1.0	22/09/17	Release document
1.1	22/05/18	Updated to correct typos, mistakes and changes in new versions
2.0	1/11/18	Updated for Compliance
2.1	8/1/2019	Add label details
2.2	21/2/2022	Update for Version 2